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Landslides and the Fault Surface Ruptures during the 2008 Wengchuan Earthquake, Sichuan, China

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2008 Sichuan earthquake with a magnitude of Mw 7.9 induced numerous mass movements around the fault surface ruptures of which maximum separations we observed were 3.6 m vertical and 1.5 m horizontal (right lateral). In order to clarify the distribution of these landslides and to characterize them, we interpreted satellite images and made field investigation for 3 weeks by using these images. We used satellite ALOS images taken by the sensors AVNIR II with a resolution of 10 m and PRISM with a resolution of 2.5 m, both of which were taken on 4th in June. We also used satellite images of before and after the earthquake provided by Google Earth.

The affected area was mountainous areas with elevations from 1000 m to 4500 m on the west of the Sichuan Basin. Ridges and valleys are generally trending NE parallel to the trends of the geologic structures, while large rivers, such as the Minjiang River, and the Fujiang River are flowing from the north or northwest to the south or southeast, crossing these trends. The NE-trending Longmenshan fault zone runs along the boundary between the mountains and the Sichuan basin (He and Tsukuda, 2003), of which Yinghsiuwan-Beichuan fault was the main fault that generated the 2008 earthquake (Xu, 2008). The basement rocks of the mountainous areas range from Precambrian to Cretaceous in age. They are basaltic rocks, granite, phyllite, dolostone, limestone, alternating beds of sandstone and shale, etc. (Geologic map of China).

Landslide distribution areas were mainly of two types: One was the area along the fault that generated this earthquake, and another was along the steep slopes of inner valleys along the Minjian River. Landslides were concentrated on the hanging wall of the earthquake fault, which appeared for more than 180 km along the Longmenshan fault zone. The distribution area of landslides was wider around the middle and the southwest parts of the surface rupture trace and became narrower to the northeast. The directions of the landslides were controlled by the fault: Landslides moving normal to the fault ruptures were most prevailing probably due to the directivity of the seismic wave. The most common landslides were of carbonate rocks, which could be attributable to the decrease in shear strength because of its dissolution by subsurface water. Relatively shallow landslides were concentratedly induced on the slopes in the valley of the Mingjian River from Yinghsiuwa through Wengchan to Maoxian. These slopes seem to be the inner gorges (Kelsey, 1998), which are formed by the acceleration of erosion, leading to the destabilization of valley slopes (Chigira, 2006). The inner valleys are as steep as 35 to 40 degrees with about 500 m height.

Largest landslide in the history occurred in the middle of the affected area. It was 1.3 km wide and 5 km long with an area of 7 million m2 and its volume may be 1 billion m3 from the images of the satellite ALOS. This landslide was preceded by gravitational deformation, which was represented by a ridge-top depression. More than 30 landslide dams were made; dams consisting of large carbonate rubbles apparently stable and dams consisting of weathered marlstone or phyllite less stable.